

Serial No.: 09/943,859
Group Art Unit: 2652

AMENDMENTS TO CLAIMS

- Please amend pending claims 1, 6, 11, and 16 as indicated below. A complete listing of all claims and their status in the application are as follows:

1. (currently amended) A method for manufacturing a hard bias spin-dependent tunneling sensor comprising:

forming a first lead;

forming a hard magnet over the first lead;

forming a free layer over the hard magnet ~~and overhanging the hard magnet~~;

forming a tunneling barrier layer over the free layer;

forming a first pinned layer over the tunneling barrier layer and overhanging the hard magnet;

forming a nonmagnetic coupling layer over the first pinned layer;

forming a second pinned layer over the nonmagnetic coupling layer;

forming a pinning layer over the second pinned layer; and

forming a second lead over the pinning layer.

2. (original) The method as claimed in claim 1 including:

forming a first gap spacer over the first lead; and

forming a second gap spacer over the pinning layer whereby the free layer is equidistant from the first and second leads.

3. (previously presented) The method as claimed in claim 1 including:

forming a first gap spacer using a bilayer process; and

forming the hard magnet includes forming the hard magnet around the first gap spacer.

4. (original) The method as claimed in claim 1 wherein:

forming the first lead includes using a bilayer process in forming a recess therein;

forming the hard magnet includes forming a seed layer in the recess of the first lead;
and

forming the hard magnet includes forming a hard biasing material over the seed layer.

Serial No.: 09/943,859
Group Art Unit: 2652

5. (original) The method as claimed in claim 1 wherein:

forming the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, and the pinning layer includes using a bilayer process;

and including:

forming an insulator over the hard magnet and around the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, the second pinned layer and the pinning layer.

6. (currently amended) A method for manufacturing a hard bias spin-dependent tunneling sensor comprising:

providing a substrate;

forming over the substrate, a shield/first lead of a conductive material;

forming over the shield/first lead, a hard magnet containing a material selected from a group consisting of cobalt, chrome, platinum, tantalum, and a combination thereof;

forming over the hard magnet ~~and overhanging the hard magnet~~, a free layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof;

forming over the free layer, a tunneling barrier layer containing a material selected from a group consisting of aluminum, chromium, an oxide, a nitride, and a combination thereof;

forming over the tunneling barrier layer and overhanging the hard magnet, a first pinned layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof;

forming over the first pinned layer, a nonmagnetic coupling layer containing ruthenium;

forming over the nonmagnetic coupling layer, a second pinned layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof;

Serial No.: 09/943,859
Group Art Unit: 2652

forming over the second pinned layer, a pinning layer containing a material selected from a group consisting of platinum, palladium, manganese, iron, nickel, iridium, an oxide, and a combination thereof; and
forming over the pinning layer, a shield/second lead of a conductive material.

7. (original) The method as claimed in claim 6 including:

forming over the shield/first lead, a first gap spacer from a nonmagnetic and conductive material; and

forming over the pinning layer, a second gap spacer from a nonmagnetic and conductive material whereby the free layer is equally spaced from the shield/first lead and the shield/second lead.

8. (previously presented) The method as claimed in claim 6 wherein:

forming the first gap spacer uses a bilayer process; and

forming the hard magnet includes forming the hard magnet around the first gap spacer.

9. (original) The method as claimed in claim 6 wherein:

forming the shield/first lead includes using a bilayer process in forming a recess therein;

forming the hard magnet includes forming a seed layer in the recess of the shield/first lead;

forming the hard magnet includes forming a hard biasing material over the seed layer; and

forming the free layer forms the free layer in contact with the hard magnet.

10. (original) The method as claimed in claim 6 wherein:

forming the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, and the pinning layer includes using a bilayer process;

and including:

forming an insulator over the hard magnet and around the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, the second pinned layer and the pinning layer.

Serial No.: 09/943,859

Group Art Unit: 2652

11. (currently amended) A hard bias spin-dependent tunneling sensor comprising:
a first lead;
a hard magnet over the first lead;
a free layer over the hard magnet ~~and overhanging the hard magnet~~;
a tunneling barrier layer over the free layer;
a first pinned layer over the tunneling barrier layer and overhanging the hard magnet;
a nonmagnetic coupling layer over the first pinned layer;
a second pinned layer over the nonmagnetic coupling layer;
a pinning layer over the second pinned layer; and
a second lead over the pinning layer.
12. (original) The sensor as claimed in claim 11 including:
a first gap spacer over the first lead; and
a second gap spacer over the pinning layer whereby the free layer is equally spaced
from the first and second leads.
13. (previously presented) The sensor as claimed in claim 11 wherein:
the hard magnet is formed around and in contact with a first gap spacer.
14. (original) The sensor as claimed in claim 11 wherein:
the first lead has a recess provided therein;
a seed layer in the recess of the first lead; and
the hard magnet is formed over the seed layer.
15. (original) The sensor as claimed in claim 11 including:
an insulator over the hard magnet and around the free layer, the tunneling barrier
layer, the first pinned layer, the nonmagnetic coupling layer, the second pinned
layer, and the pinning layer.
16. (currently amended) A hard bias spin-dependent tunneling sensor comprising:
a substrate;
a shield/first lead of a conductive material over the substrate;
a hard magnet containing a material selected from a group consisting of cobalt,
chrome, platinum, tantalum, and a combination thereof over the shield/first
lead;

Serial No.: 09/943,859

Group Art Unit: 2652

a free layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof over the hard magnet ~~and overhanging the hard magnet~~;

a tunneling barrier layer containing a material selected from a group consisting of aluminum, chromium, an oxide, a nitride, and a combination thereof over the free layer;

a first pinned layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof over the tunneling barrier layer and overhanging the hard magnet;

a nonmagnetic coupling layer containing ruthenium over the first pinned layer;

a second pinned layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof over the nonmagnetic coupling layer;

a pinning layer containing a material selected from a group consisting of platinum, palladium, manganese, iron, nickel, iridium, an oxide, and a combination thereof over the second pinned layer; and

a shield/second lead of a conductive material over the pinning layer.

17. (original) The sensor as claimed in claim 16 including:

a first gap spacer of a nonmagnetic, hard, conductive material over the shield/first lead; and

a second gap spacer of a nonmagnetic, hard, and conductive material whereby the free layer is equidistant from the shield/first lead and the shield/second lead.

18. (original) The sensor as claimed in claim 16 wherein:

the hard magnet is formed around and in contact with the first gap spacer.

19. (original) The sensor as claimed in claim 16 wherein:

the shield/first lead has a recess provided therein;

and including:

a seed layer in the recess;

and wherein:

the hard magnet is formed over the seed layer; and

the free layer is formed in contact with the hard magnet.

Serial No.: 09/943,859

Group Art Unit: 2652

20. (original) The sensor as claimed in claim 16 including:
an insulator over the hard magnet and around the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, the second pinned layer and the pinning layer.